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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1627

THE HESSIAN FLY

AND HOW LOSSES FROM IT CAN BE AVOIDED

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THE HESSIAN FLY undoubtedly is the most injurious insect enemy of wheat in the United States. During the last 45 years at least eight general outbreaks of this pest have occurred in the States east of the Mississippi River. These invasions have averaged about one every five or six years, although they have occurred at rather irregular intervals. A very destructive one was at its height during the period from 1914 to 1916. Serious and widespread injury occurred again in 1919 and 1920.

Local outbreaks occur nearly every year. In 1927 the loss in Kansas was estimated at 20,000,000 bushels, and material injury occurred the same year in the Middle Atlantic States. The average annual damage to wheat throughout the United States has been estimated at many millions of dollars.

A large part of such losses is preventable, although no remedy is known which will destroy the pest or save the crop once it has become thoroughly infested. Control and preventive measures are described on pages 11–13 and summarized on page 14.

This bulletin is a revision of and supersedes Farmers' Bulletin No. 1083, The Hessian Fly and How to Prevent Losses From It.

Washington, D. C. Issued May, 1930

THE HESSIAN FLY[1] AND HOW LOSSES FROM IT CAN BE AVOIDED

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ECONOMIC IMPORTANCE

IN THE PRINCIPAL winter-wheat-growing regions of the United States the Hessian fly is the most injurious insect enemy of the wheat crop. It occurs throughout this territory, except in the extreme southwestern part, and is always alert to take advantage of favorable weather and crop conditions to multiply rapidly. Damage amounting to at least $100,000,000 in a single year has been known to result from its work.

The Hessian fly is injurious chiefly to wheat, but at times injures barley and rye to a lesser extent. It does not attack oats at all. In a few instances the insect has been reared from grasses, but it is not known to infest them heavily.

Its common name was bestowed upon this insect long ago by Americans because of its depredations on Long Island, N. Y., in 1779, in the vicinity of Lord Howe's encampment of three years before. On the supposition that the pest had been brought from their native country in the straw used for their bedding by the obnoxious Hessian mercenaries who constituted a part of this army, it was given the name of "Hessian fly." The pest is generally believed to have crossed the Atlantic some time in the latter half of the eighteenth century.

[1] *Phytophaga destructor* Say; order Diptera, family Itonididae.

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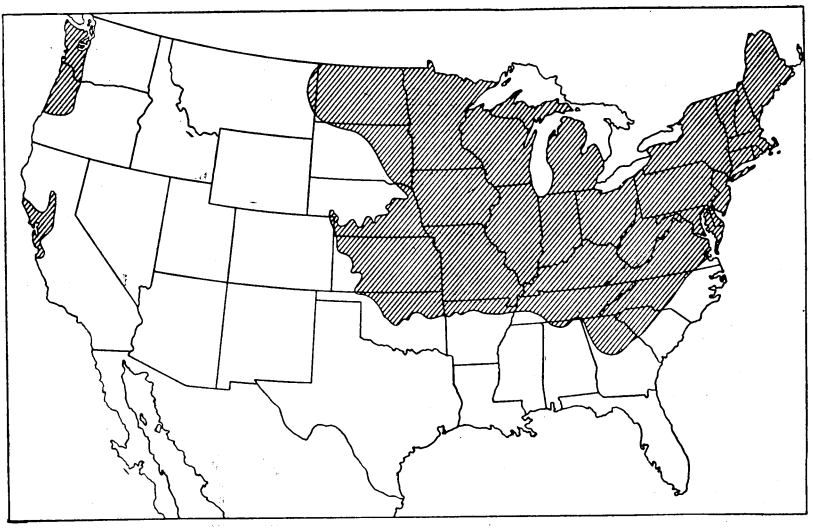

FIGURE 1.—Map showing distribution of the Hessian fly in the United States

REGIONS WHERE THE HESSIAN FLY IS MOST INJURIOUS

The present preferred home of the Hessian fly, generally speaking, is that portion of the country lying east of the one-hundredth meridian and between the thirty-fifth and forty-fifth parallels of north latitude. It is found outside of this area, but usually not as a serious menace to the wheat. The fly also is found in the Pacific coast region, but is not nearly so destructive there as it is east of the Rocky Mountains. The map (fig. 1) shows the distribution of the insect in the United States.

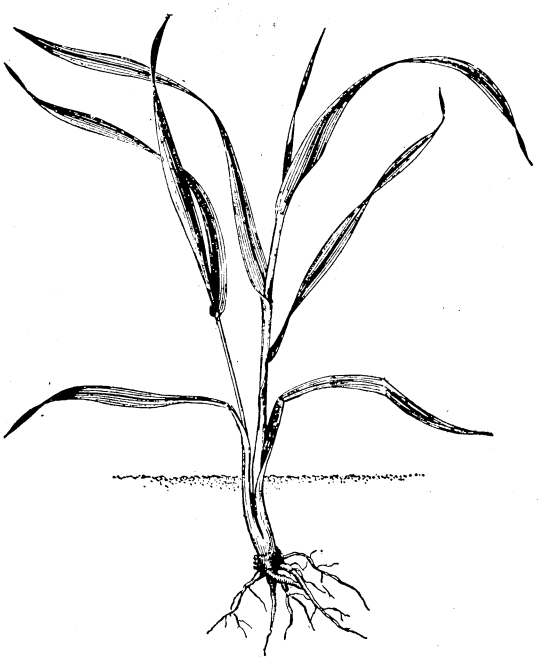

FIGURE 2.—Healthy young wheat plant

The fly is also found in the Dominion of Canada from Prince Edward Island over most of Manitoba to Moose Jaw, Saskatchewan, and in British Columbia. Outside of North America, it is known in northern Africa, western Asia, Europe, Great Britain, and New Zealand.

NATURE OF INJURY

The injury by the Hessian fly to wheat and other grains is caused by the feeding of the maggots located between the leaf sheaths and the stems. They extract the juices of the young growing stems, causing the death of small tillers, and so weakening the older stems at the point of attack just above the joints that they break over shortly before harvest when the heads have grown heavy with grain. In cases of serious infestation much of the young wheat is killed outright by the work of the fall brood. The maggots of the spring brood may also kill out the plants in the same way, but the most obvious damage that they do is to cause the breaking over or "lodging" of the stems after these have developed heads. Not only is the quality of the grain reduced, but many such heads fall below the point where they can be taken up by the harvesting machinery.

EFFECT OF LARVAL FEEDING ON THE PLANT

The effect of the feeding of the larvae on a young wheat plant is very marked and may be observed soon after the young reach the stem under the sheath. Once an infested plant has been seen, it is usually possible afterwards to detect other infested plants.

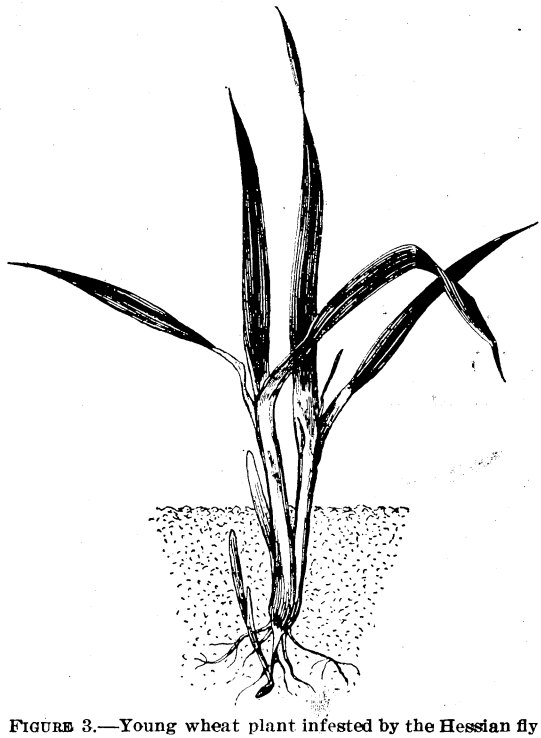

FIGURE 3.—Young wheat plant infested by the Hessian fly

For comparison, illustrations are given of a normal young plant (fig. 2) and of an infested young plant. (Fig. 3.) An uninfested plant is of a more slender growth, the green color is lighter, the stems are more or less visible, and the central unrolling leaf is present. The leaves are inclined to droop, and the tillers spread out and cover the ground. In an infested tiller the leaves are more erect, broader, and usually shorter, and of a darker green. Tillers infested in the fall usually perish during the winter.

Figure 3 shows a young tiller starting out from below the part attacked by the fly. If this is attacked after it appears above ground it assumes the same appearance as the original shoots. Its leaves become broader and of a darker color. This applies equally to a severe attack on fall wheat in spring or on young spring wheat.

Although the spring wheats have a more upright habit of growth, and the hard wheats are naturally a somewhat deeper green, the more erect, shorter, darker leaves of infested plants will still enable the observer to detect the infestation. Later on the infested tillers

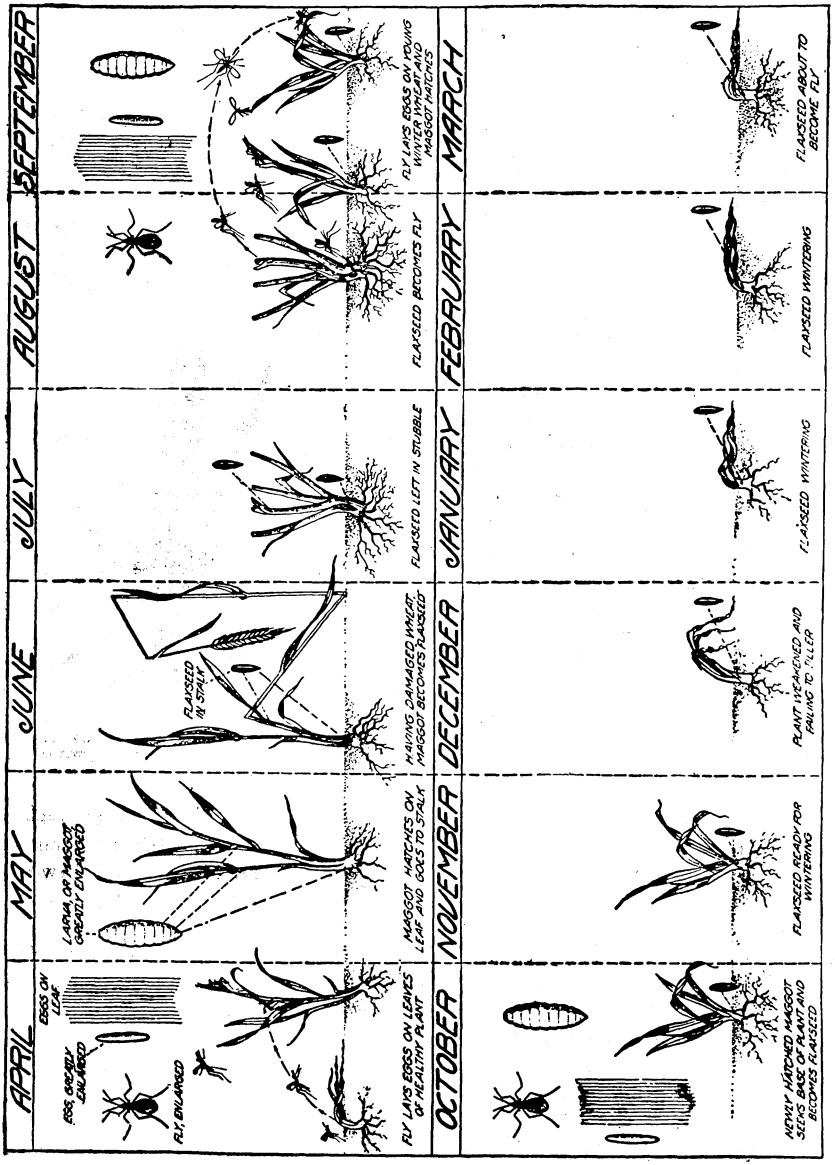

FIGURE 4.—Diagram showing seasonal development of the Hessian fly

change to yellow and then to brown, but the darker color and coarser growth of leaf always precede this. The presence of little greenish-white maggots or brown flaxseeds under the leaf sheaths, just above the bases or joints of the affected stems, is definite evi-

dence that the symptoms just described are caused by the Hessian fly.

LIFE HISTORY

In the winter-wheat regions of this country the Hessian fly has two principal generations annually—one in the spring and one in the fall. (Fig. 4.) In the South the spring generation becomes active earlier and the fall generation continues its activity later in the season than in the North.

Throughout the winter-wheat-growing regions the fly passes the winter in the young wheat, mostly in the resting or flaxseed [2] stage, but in mild winters it may hold over to some extent as larvae from two-thirds to full grown.

In spring (from March in Georgia and South Carolina to May in Michigan) the flies escape from the flaxseeds in the young plants, deposit their eggs on the wheat (fig. 4, upper leaf), and the young from these develop to flaxseeds (fig. 5) before harvest and pass the summer in the stubble.

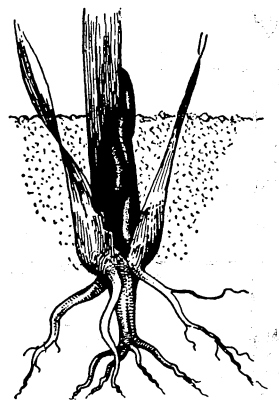

FIGURE 5.—Hessian fly flaxseeds on young wheat. Twice natural size.

In some seasons there appears before harvest a so-called "supplementary" brood of flies composed of delayed individuals from some of the overwintering flaxseeds and of flies from some of the newly developed spring puparia. Sufficient rainfall and humidity to cause germination and vigorous growth of volunteer wheat during the summer may also cause the development of a late summer brood of flies for which the volunteer wheat serves as a breeding place. Such infested volunteer wheat thus becomes an additional source of flies which infest planted wheat in the following fall or spring.

In the fall, under normal weather conditions, adult flies begin to come out of the stubble in late August and early September. Stragglers may continue to issue as late as the first of December in the latitude of Georgia and South Carolina, but in the most northern States the lower fall temperatures usually stop the emergence of flies in any great numbers before the end of September. Although adults may emerge in varying numbers during a period of several weeks, most of them usually appear and disappear within the space of a week or so—early enough in the fall for wheat planting to be safely delayed until serious danger of infestation is past. The flies prefer to deposit their eggs on the younger plants, those having from one to three leaves seeming to suit them best. The fall brood of young maggots hatching from these eggs make their way downward nearly or quite to the root crowns. (Fig. 5.) Normally they complete their development as larvae, pass into the flaxseed stage, and spend the winter as such on the young wheat plants. (Fig. 5.) The earliest deposited eggs on the earliest sown wheat, however, under favorable conditions may produce adults before the winter sets in, and in this

[2] The so-called flaxseed of the Hessian fly is described in detail on p. 7.

case the delayed individuals emerging from stubble or volunteer wheat at this time combine with them to produce another so-called "supplementary generation." The importance of this supplementary generation depends largely on the weather. When winter sets in before the larvae have matured sufficiently to withstand its rigors, these necessarily perish, but if the mild fall weather is greatly prolonged, a greater or less number of them may winter over uninjured.

DESCRIPTION AND LOCATION OF VARIOUS STAGES

The egg is very minute, being only about one-fiftieth of an inch in length, but it may be readily seen by one having ordinarily good sight. It is slender and almost cylindrical, with both ends bluntly rounded. The surface of the egg is glossy and of a pale red, which deepens with age. The eggs are usually placed in the grooves of the upper surface of the leaves.

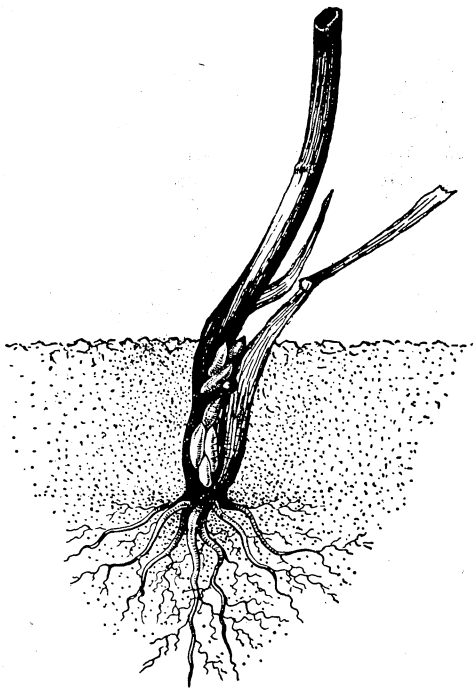

FIGURE 6.—Hessian-fly maggots beneath leaf sheath in the soil. Natural size

The newly hatched larva, or maggot, is about the same size as the egg and has the same general color, but this changes to white within a few days. Immediately after it is hatched it makes it way down the leaf and behind the sheath. In the case of young wheat it descends to just above the roots, but after the plants have begun to joint it can go no farther than the base of the sheath belonging to that particular leaf, which is always at a joint. Where excessively abundant many larvae crowd together side by side or behind one another under the same sheath. This condition usually accompanies a heavy infestation.

The fall brood of larvae and the overwintering flaxseeds are to be found just above the roots and below the surface of the ground. (Fig. 6.) In the spring generation the larvae and flaxseeds are to be found in different locations, depending upon the maturity of the plants at the time the infestation occurs. In case the flies emerge before the joints have begun to form in the wheat stems, the larvae and flaxseeds locate under the leaf sheaths arising from the bases of the stems. (Fig. 6.) When the adults emerge after the stems

have begun to form joints, many of the larvae and flaxseeds become established just above the joints under the leaf sheaths arising from those joints.

When the larva becomes full grown it is naked, glistening, and flaky white, with a translucent, greenish stripe down the middle of the back where the stomach contents show through. (Fig. 7.) The skin soon hardens and turns brown, forming what is called a puparium. The insect then quite closely resembles a flaxseed (fig. 8), and often is referred to by that name. This is not the pupa (fig. 9), which is formed subsequently after the larva has reversed its position inside the flaxseed and lies with the head pointing upward.

If the flaxseed is not situated conveniently for the emergence of the adult the pupa pushes itself, if possible, to a point of escape, and frequently the empty pupal skins may be observed protruding from under the sheaths of leaves.

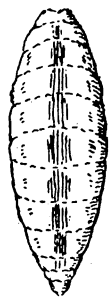

FIGURE 7.—The Hessian-fly larva before flaxseed is formed. Magnified 12 diameters

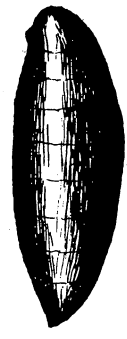

FIGURE 8.—The Hessian-fly puparium or flaxseed. Magnified 12 diameters

FIGURE 9.—The Hessian-fly pupa removed from the flaxseed. Magnified 12 diameters

The adult fly is not easily observed until one becomes familiar with its appearance and looks for it at the right time. It is very minute and somewhat resembles a small mosquito (figs. 10 and 11), but other gnats common in wheat fields may be easily mistaken for it. Many entirely different species of insects seen in the fields by growers are often incorrectly assumed to be the Hessian fly. During warm days in the egg-laying season, the flies may be observed flying about in the young wheat and alighting and laying eggs upon the leaves. On cooler days, or in early morning when there is a heavy dew, they are down among the leaves or even on the ground. The adult flies live only a few days, the period depending somewhat upon temperature conditions.

RELATION OF THE WEATHER TO THE HESSIAN FLY AND ITS CONTROL

All who have studied the Hessian fly carefully under various field conditions during a series of years have noted that weather condi-

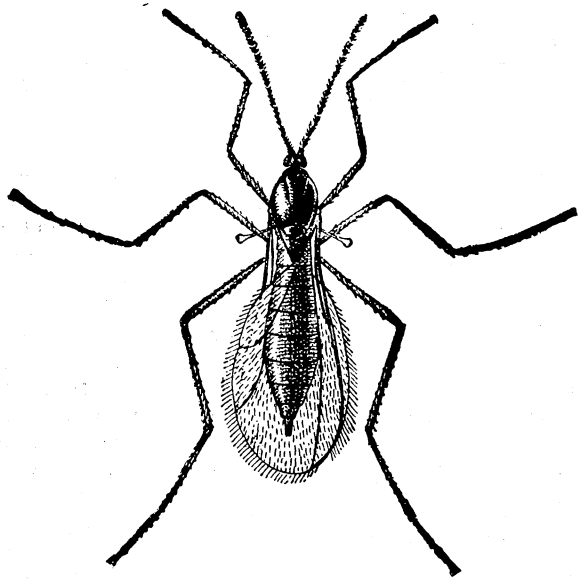

FIGURE 10.—The Hessian fly: Adult female. Magnified 11 diameters

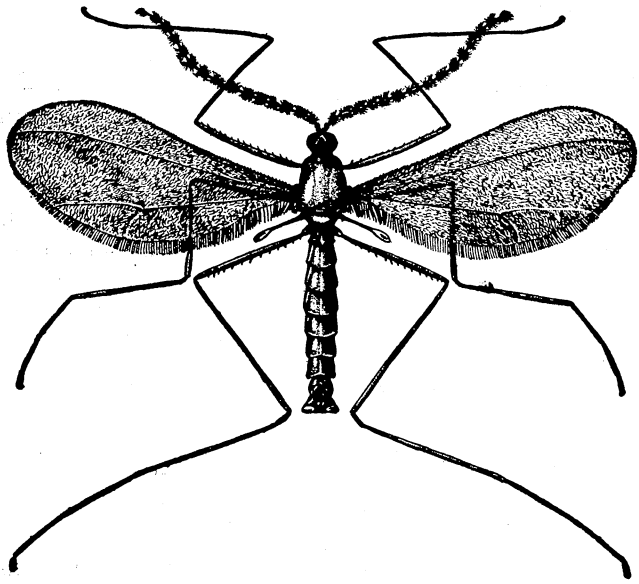

FIGURE 11.—The Hessian fly: Adult male. Magnified 11 diameters

tions have an important influence on the insect, and in the application of preventive measures these weather conditions become of vital importance.

Many wheat growers believe in the effectivness of cold weather, or even of frosts, in terminating the activities of the flies in the fall and try to delay wheat sowing until after there has been a sharp frost. There is some ground for this belief, since emergence of flies already in the pupal stage, egg laying, and development of the young maggots, are retarded by such low temperatures. Also, maggots which have not already begun pupation inside their flaxseeds will not do so while the average daily temperature remains much below 50° F. Warmer periods during the fall, however, may allow considerable fly activity. Egg laying sometimes takes place in rather chilly weather, and the eggs have been known to remain in a temperature of 36° for several hours with no other effect than to delay their hatching that much longer. Eggs have been observed hatching in the daytime in fields when there were frosts nearly every night. Though the freedom of late-sown wheat from attack by the fly may be attributed partly to the advent of frosty weather, it should be understood clearly that this freedom is due largely to the fact that most of the adult flies usually are dead by the time severe frosts normally occur.

The most marked influence of climatic conditions on this insect is seen in the effect of heat and drought, and especially of the two combined. The larvae in the flaxseed form have been known to survive for more than two years under dry conditions and afterwards emerge as adults. Drought delays the emergence of the adult flies in the fall. This fact is of special importance in the North, where it is necessary to get the wheat sown early to enable the plants to withstand the severe winter weather. But extreme summer heat combined with dryness prevents this insect from surviving in the more arid wheat-producing regions of the West and Southwest.

Many years ago it became definitely known that wheat sown on or after certain dates in the fall usually escaped infestation by the Hessian fly. It was established that these dates varied with latitude and elevation, becoming earlier at a more or less uniform rate as one progressed northward or upward. In more recent years the best average safe dates in most States have been determined for different localities from a series of sowings on different dates in each locality, repeated annually for a number of years. In some States, also, the best dates to begin sowing are determined each fall by continuous observation of fly activities in several localities, the farmers being advised not to begin sowing until this date is determined, and being informed promptly as soon as it has been ascertained. The wheat grower should obtain the safe-sowing date for his locality from the county agricultural agent or the nearest experiment station.

NATURAL ENEMIES

There can be no doubt that parasites play a very important part in the natural control of the Hessian fly. Twenty-nine species of insects are now known to be parasitic on the immature stages of the fly in this country, but many of these species are rather rare. Figures

12 and 13 show two of the most common ones. Though 75 per cent or more of the flaxseeds are sometimes killed by parasites during the summer, the reproductive ability of the fly is so great that, given

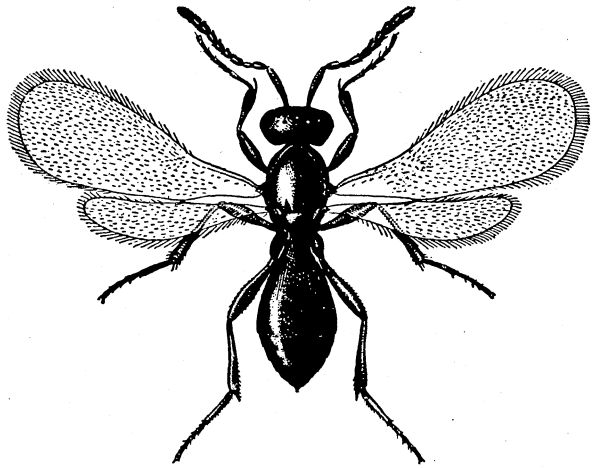

FIGURE 12.—*Platygaster hiemalis*, a parasite of the Hessian fly. Enlarged 38 diameters

favorable weather conditions, a serious infestation may still develop in the following crop of wheat. Parasitism often helps materially to reduce the intensity of the Hessian-fly infestations, but ordinarily

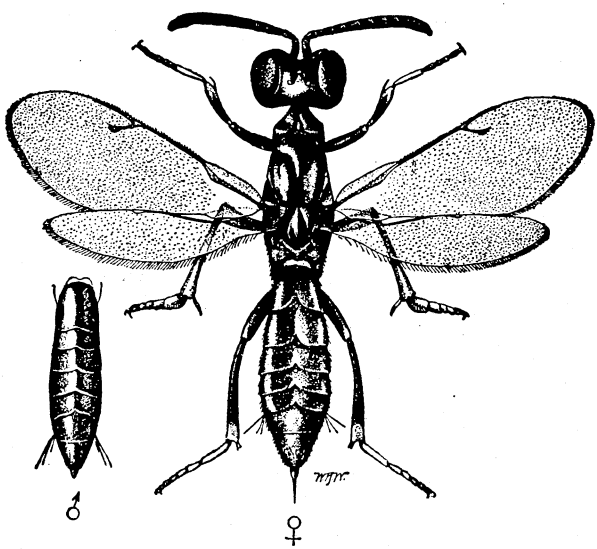

FIGURE 13.—*Eupelmus allynii*, a parasite of the Hessian fly: Female, with abdomen of male shown at left. Enlarged 20 diameters

it is not the controlling factor influencing fly abundance. No way has been devised of artificially increasing the effectiveness of parasites, and they can not be relied upon for certain help. Hence it

is necessary for wheat growers to practice at all times the preventive measures recommended in the following pages.

CONTROL MEASURES

USEFUL MEASURES ALL PREVENTIVE

Of direct remedies for the Hessian-fly injury there is little to be said, since after the pest becomes established in a field it can not be reached by any measure likely to destroy it. All useful measures yet known are in the nature of preventives, keeping the pest from attacking young wheat in the fall, and increasing the vigor of the young plants in order to enable them to counteract the insect's effect when present. Under the first category come late sowing, rotation of crops, the plowing under of stubble, and the destruction of volunteer wheat. Under the second should be classed the enrichment of the soil, its thorough preparation, and the selection and proper sowing of the best seed.

CROP ROTATION DESIRABLE

For Hessian-fly control wheat should not be grown on the same land two years in succession where it is practicable to avoid this, as the continuous planting of wheat increases infestation not only by the Hessian fly but also by other insect pests which infest wheat stubble, such as the jointworm, the strawworm, and the wheat-stem sawflies. Such a rotation of crops should be practiced as is approved by local farm advisers or State experiment stations.

PLOWING DOWN STUBBLE BENEFICIAL

Where it can be practiced the plowing under of stubble soon after harvest has been found to aid greatly in reducing the abundance of the pest. Plowing must be deep and thorough to be effective, and the surface should be harrowed or rolled afterwards to close the openings in the soil and prevent the flies from emerging. While this method of control is not advised for regions where the best crop rotations call for the sowing of grass and clover in the growing wheat, it is practicable in most of the great wheat-growing area west of the Mississippi River. The plowing under of the stubble as soon as possible after harvest, followed by proper cultivation to keep down volunteer growth, not only reduces the fly menace but improves soil conditions for the following crop so that the yield is increased. The practice is highly recommended wherever cultural conditions will permit.

DESTRUCTION OF VOLUNTEER WHEAT FATAL TO THE FLY

Volunteer wheat serves as a breeding place for the Hessian fly between regular crops and should be eliminated wherever possible by disking, plowing, or some other method.

This is a very important and valuable measure in Hessian-fly control and can be accomplished by the same cultural operations used for eliminating the stubble. The destruction of volunteer wheat, like the plowing under of stubble, is not practicable in those regions where grass and clover are sown in the wheat, but by all means it should be practiced wherever possible.

PROPER PREPARATION OF THE SOIL IMPORTANT

It matters little whether a soil has much or little fertility if that fertility is bound up in clods or hard lumps out of reach of the rootlets of the young plants. Early plowing and thorough working and compacting of the soil eliminate the lumps and clods and produce a finely pulverized, compact, moisture-conserving seed bed, from which, as soon as rootlets are sent out from the seed kernel, the shoot begins to draw nourishment. This condition gives vigor to the plants and thus enables them, by freely tillering, to outgrow a light attack of the fly that otherwise might prove serious.

CONSERVATION OF MOISTURE AIDS GERMINATION

The seed bed should be prepared in advance of seeding. If rain occurs before the date set for sowing, the ground should be harrowed to conserve the moisture so that the wheat will germinate promptly even if the weather should turn dry. This is an important point frequently overlooked by growers.

THE USE OF GOOD SEED ESSENTIAL

As the seed kernel must contain sufficient nutriment to sustain the plant until it can support itself by drawing from the soil, any deficiency in the seed necessarily tends to weaken the plant at the very beginning of its existence. Thus good seed becomes the first requisite in securing the healthy, vigorous plant that is to be further strengthened and sustained by a well-prepared, fertile soil. It is clear then that all shrunken, dwarfed, or otherwise imperfect kernels or weed seed, especially cockle, should be cleaned out of the seed before it is sown and only the largest and most perfect grains retained.

ENRICHING THE SOIL MAKES VIGOROUS WHEAT

Wheat growing in fertile, rich soil withstands both Hessian-fly and jointworm injury much better than that growing in poor soil. Therefore keep the soil of wheat land in good tilth at all times by following the methods approved by agricultural experts for your particular locality.

DATE OF SOWING TO ESCAPE INJURY

Late sowing as here recommended means moderately late sowing of fall wheat in any locality, because extremely late sowing, which sometimes has been advised, is even worse than early sowing. Experiments conducted over a period of many years have shown that in most localities the safe date for sowing winter wheat to escape Hessian-fly injury in years of normal rainfall usually coincides fairly well with the proper time for sowing in order to secure maximum yields of grain. The best average dates to begin sowing wheat in order to avoid the Hessian fly in different parts of the winter-wheat belt are shown in Figure 14. In a normal year wheat sown during the 10-day period immediately following these dates stands the best chance of escaping injury by both fly and winter killing.

The dates shown are only approximate and serve to indicate about the time when the fall brood of the fly has disappeared. Farmers should consult the county agricultural agent or nearest experiment

station to obtain additional information on the safe-sowing dates recommended for their immediate localities. All are dependent upon latitude, altitude, longitude, weather fluctuations, and other local conditions. The date varies considerably in broken or hilly country, even on the same farm, being appreciably later on the southern slope of a hill than on the northern slope of the same hill. Because of the fact that the larger part of the fall brood appears and is gone within a week or so, it is possible so to time the seeding of winter wheat as to avoid the Hessian fly, and this is one of the most practical and effective measures that can be applied.

COOPERATION NECESSARY

Though much benefit may accrue to individual farmers from the use of the control methods now available, the full value of most of them can be secured only by their adoption throughout whole neigh-

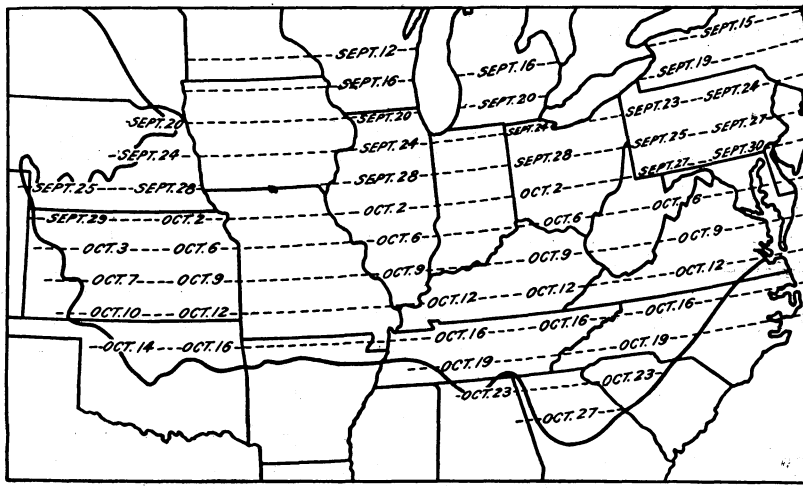

FIGURE 14.—Map showing the earliest safe-sowing dates to avoid injury by the Hessian fly. These dates are only approximate. Farmers should consult their county agricultural agent or nearest experiment station to obtain more exact information on the safe-sowing dates recommended for their immediate localities

borhoods. Though one farmer may prevent infestation from originating in his own fields, his young wheat may still be injured by flies emerging from his neighbors' fields unless they too have taken steps to prevent it. Cooperation is essential to prompt and effective reduction of Hessian-fly outbreaks.

IMPRACTICAL MEASURES FOR CONTROL

Many expedients which have been suggested for the control of the Hessian fly are useless or of very doubtful value. Burning the stubble to kill the flaxseeds; rolling, pasturing, or mowing the young wheat to kill the immature stages of the insect; and early planting of trap strips or decoy plots of young wheat to concentrate the flies for destruction later by plowing the strips under, have all been proven by experience to be ineffective or impractical.

SUMMARY OF CONTROL MEASURES

There is no remedy for the Hessian fly when once it has taken possession of a crop of wheat. Injury can be prevented in only one way, namely, by keeping the fly out of the wheat. The following methods are reliable and should all be observed where it is possible to do so.

(1) Practice crop rotation. Do not sow wheat on wheat stubble if it is possible to avoid doing so.

(2) Plow under all infested stubble, where practicable, soon after harvest. Plow under ruined wheat as soon as possible after it has become certain that the crop will be a failure.

(3) Destroy all volunteer wheat where possible, by harrowing, disking, plowing, or some other method.

(4) Plow all land to be sown to wheat as early and deeply as existing conditions permit, and prepare a thoroughly pulverized and compacted seed bed.

(5) Conserve moisture against a period of drought at seeding time.

(6) Use good seed.

(7) Fertilize.

(8) Sow wheat during the fly-free period as advised by your county agricultural agent or State experiment station.

Adhere to these practices every year whether the fly is abundant or scarce. They will help to keep it scarce.

Finally, cooperate. Without community cooperation success can not be attained, because one infested field may furnish enough flies to damage the wheat in several near-by fields.

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